Improving Access to Healthy Food in Durham's Food Deserts: A Policy Analysis

by

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Abstract

The USDA categorizes food deserts as low-income census tracts with poor access to fresh produce. This lack of access to healthy food has been linked to public health problems such as obesity, diabetes, strokes, and cardiovascular diseases, leading to higher disease rates, health bills, and mortality rates within food deserts. Today in Durham, over 43,200 residents live in food deserts; this is 16.2% of the county population, and 16,800 more people than in 2012. To address the growing food desert problem in Durham, this report will develop a set of policies detailing how the city government along with private businesses can improve food access. The policies considered will target ways to improve access, specifically to locally sourced produce, in order to promote local agriculture and businesses as well. Furthermore, the policies will focus on short-term access and only those that do not overlap with federal food desert policy. Four policies will be analyzed: (1) the status quo, (2) added benefits to Electronic Benefit Transfer (food stamps) and Women, Infants, and Children benefits for shopping at local markets, (3) establishing new farmers' markets in food deserts, and (4) establishing mobile markets operating in food deserts. They were developed based on case studies of other municipal actions to improve food access, and interviews with local stakeholders to apply them to Durham. Each policy will be analyzed based on its expected costs and benefits, its political feasibility and actors required for implementation, equity concerns, and the policy's improvability and adaptability.

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Introduction

On March 18, 2013, the Durham City Council amended the Unified Development Ordinance to allow for commercial crop production and farmers' markets in residentially- and commercially-zoned plots within the city. This expanded Durham's rapidly growing urban farming sector and provided an outlet to sell these goods throughout the city. At the same meeting, the Council recognized Diabetes Alert Day, in order to fight against rising levels of diet-based health issues, particularly in the low-income areas of the city. Levels of diabetes and obesity have been growing in recent years, with 26.4% of Durham's adults now obese and 7% with diabetes (Partnership for a Healthy Durham, 2012). Contributing to this growth has been the exodus of grocery stores from poor neighborhoods, leaving the city's residents with the least mobility farthest from healthy foods (Dutko, Ver Ploeg and Farrigan, 2012).

The connection between these two Council matters seemed natural: restricting the production and sale of local, fresh crops in the city leaves residents with few alternatives to the chain restaurants that dominate the poor neighborhoods. However, the City Council drew no links between these two items. Durham has now taken the first step, by no longer restricting the local agricultural sector and allowing for the widespread sale produce through local markets. This step not only legalized many urban farming operations that are already underway, but it paves the way for a large expansion of urban farming in Durham. This report examines Durham's policy options in order to proactively support local industries and address public health by improving access to locally produced foods within the city's food deserts. Certain policies will require action by the Durham City Council. Others do not necessarily require municipal action, but could be greatly aided by

institutional support. In order to develop and analyze these policies, I will examine the current state of food deserts in the city, the link between food deserts and health outcomes, and case studies detailing how other cities have targeted food deserts. After this, I will consider several policy alternatives for the city or local agricultural businesses to pursue to determine the most effective set of policy options.

Food Desert Definition and the US Context:

Food deserts were first identified as an issue in the 1990's in Scotland, with food deserts defined as "low income, urban areas with diminished walking distance access to grocery stores," (Sparks 1, 2009). It was originally used to explain why produce prices may be more expensive than average in low-income areas, as less dense regions could not match economies of scale for mass produce purchasing seen in wealthier suburbs. Concerns over food deserts reached the federal level of the US Government in 2008, when that year's Farm Bill provided a formal definition of "food desert" and commissioned a study to examine their impacts (Agricultural Marketing Service, 2011).

The official US Department of Agriculture definition of a food desert is a "census tract with a substantial share of residents who live in low-income areas that have low levels of access to a grocery store or healthy, affordable food retail outlet," (Agricultural Marketing Service, 2013). In order to quantify these terms, they have defined "low-income" as census tract with either "a) a poverty rate of 20 percent or greater, or b) a median family income at or below 80 percent of the area median family income," (Agricultural Marketing Service, 2013). "Low-access" is defined as regions in which either "500 persons and/or at least 33% of the census tract's population live more than one mile from a supermarket or large grocery store," (Agricultural Marketing Service,

2013). Based on this definition, the USDA estimates that 23.5 million Americans live in food deserts with over 90% of these people live in cities (Agricultural Marketing Service, 2013). This definition makes it clear that health outcomes and affordability are the central concerns surrounding the food desert problem. Thus, eliminating food deserts has become a major goal of the Let's Move campaign, spearheaded by Michelle Obama to reduce childhood obesity. In fact, a "lack of access to proper nutrition" within food deserts is cited as a key reason for high obesity rates (The Executive Office of the President, n.d.).

The centerpiece of the Obama Administration's efforts to combat food deserts is the Healthy Food Financing Initiative (HFFI). The policy is modeled after one implemented in Philadelphia. In 2004, Philadelphia allocated $30 million to provide low-interest loans to supermarkets being constructed or renovated to provide more fresh produce in food deserts (The Policy Link, n.d.). It has been seen as a major success, as the initial State money was met with $190 million of private investments (Hagey, 2012). As of 2012, 88 grocery stores have been built or renovated in former food deserts, providing access to fresh food for over 400,000 residents. These investments have also created 5,000 new jobs, and hundreds of thousands of dollars in annual tax revenue (Hagey, 2012). There have been no studies of the impact on neighborhood health changes since the FFFI began, so its full benefits cannot yet be determined. The Federal HFFI extends this throughout the country, providing low-interest loans and tax credits to supermarkets beginning or expanding operations in food deserts (Office of Community Services, 2011). Since 2011, the Department of Health and Human Services and the Department of Treasury have distributed over $500 million for such projects (Hagey,

2012). The HFFI was recently reauthorized in the 2014 Farm Bill; however, the same bill cut SNAP benefits (food stamps) by $8.6 billion, which could affect the ability of low-income communities to afford this produce (O'Keefe, 2014).

Finally, there has been recent debate over the use of the term "food desert," as many of these neighborhoods have an abundance of unhealthy, high-calorie food found in fast food restaurants and convenience stores. Thus, some refer to the problem as "food swamps," as the areas are generally not devoid of food; rather they are thick with unhealthy food that, when consumed in excess, can create a public health crisis (Black, 2009; Nathaniel, 2012). Residents of these low-income areas are regularly exposed to cheap, fast food options, which generally taste better, and can be eaten immediately. For many low-income families in these areas, the high calorie to dollar ratio presented by fast food options are far more affordable and convenient than taking time to travel to grocery stores and cook a healthy meal. The lack of strong nutrition education helps to compound this problem.

Methods

This analysis will build off of the results of a Masters Project completed by Sarah Parsons in 2012, which analyzed the applicability of the official food desert definition, barriers to food access in Durham's food deserts, and mapped Durham's food deserts at a finer scale than census blocks. Unfortunately, these maps cannot be used in this analysis as Durham's food deserts have changed significantly in the past two years. Parsons' report proposed a continuum of 14 neighborhood characteristics to define food deserts rather than the simple, low-income and low-access USDA definition. After conducting group interviews with residents of food deserts, Parsons found several major barriers to

accessing healthy food. The major barriers were found to be cost, lack of EBT readers, geographic distance from fresh produce and high trip costs, lack of knowledge about assistance programs, language barriers (particularly for the Latino community), prevalence of fast food, and lack of cooking knowledge using fresh produce (Parsons, 2012).

The goal of this analysis is to build off of Parsons' report by identifying and analyzing strategies to increase access to healthy and fresh produce in Durham's food deserts, specifically locally sourced produce. The emphasis on local produce will provide benefits to Durham by supporting small businesses, as well as improving health outcomes in food deserts. Federal policies exist to support the construction and renovation of supermarkets, so the strategies examined here will not overlap with the HFFI, rather focus on local means of improving access. Finally, priority will be given to policies that improve food access as soon as possible. All three policy alternatives analyzed in this report would improve access to fresh produce as soon as they are implemented. This short-term priority means that education-based policies, while necessary for improving health outcomes in food deserts in the long-term, will not be considered.

In order to develop and analyze effective policies, this report will explore the literature regarding the root causes of food deserts and their context in Durham. Next, three policy alternatives will be described, and compared to the status quo in Durham. These policies were developed by examining other municipal actions around the US to provide fresh produce in urban food deserts. All the policies will require action from private businesses, however, the primary focus will be statutes that the Durham City Council can adopt in order to support these businesses and encourage them to enter

underserved markets. Recommendations to businesses will be limited to location-based strategies to best serve Durham's food deserts. To provide location suggestions, geographic information systems (GIS) analysis was used in order to determine locations that would be most viable for a market while serving the residents of food deserts.

To adapt and apply the policies from other municipalities Durham, ten interviews were carried out during the fall and winter of 2013-2014. Many more interview requests were sent out, however response rates were very low from businesses and relevant officials within Durham. The final interviews consisted of three current or former market managers, three members of community groups that focus on food policy in Durham, three employees or owners of businesses that help provide local food to Durham, and finally with Sarah Parsons to fully understand the barriers she identified in her report.

The following policies will be considered: (1) no action, or the status quo, (2) subsidizing food bought at farmers' markets through added benefits to Electronic Benefit Transfer cards (EBT, the means of distributing food stamps) and Women, Infants, and Children (WIC) benefits, (3) establishing new farmers' markets in food deserts, and (4) establishing mobile markets in food deserts, either through a farmers' food truck, small-scale food stands near community centers, or both. After each policy is described, they will be evaluated based on its expected costs and benefits, the necessary action required by City Council and local businesses for implementation, equity concerns, and the policy's adaptability and improvability once implemented. A final discussion will recommend which policies to adopt.

II. The Food Desert Problem

Food deserts arise from two major trends in the second half of the 20th Century, sprawling suburban development, and the industrialization of the food industry (Mead, 2008; John Hopkins Center for a Livable Future, 2010). Both have greatly impacted how people access their food, the types of food people eat, and therefore public health. Finally, race has been shown to be a major predictor of food desert location, even more so than income (Story et al., 2008). All three issues will be discussed, and then considered within the context of Durham to examine causes of food deserts, necessary to implement effective policies.

Suburbanization

Since the end of World War II, the US and other advanced economies have seen a suburbanization of their populations. This less dense development pattern was made possible by the diffusion of personal automobiles, and heavy investment in highway infrastructure. In 1950, out of metropolitan areas, the urban center accounted for 70% of jobs and 57% of the population. By 1970, this was down to 55% of jobs and 43% of the population (Kopecky and Suen, 2010). The rapidly growing population and economy at the time makes these statistics even starker. Car ownership increased too, from 59% of US households in 1950 to 82% in 1970. This suburbanization has also been categorized as "White Flight" as many of those who remained in urban centers were minorities, and those who could not afford a car, suburban home, and a daily commute. By 1973, 64% of poor people in metropolitan areas lived in the urban center (Blakeslee, 1978). With declining populations, density, and wealth in urban centers, local businesses were greatly affected. Supermarkets with large parking lots replaced corner grocery stores, which

relied on density. The effect was decreased access to groceries for the urban poor. A study in London found that in 1961, 75% of the inner-city population lived within 1 km of a grocery store. By 2005, it was less than 20% (Mead, 2008).

Industrialization of Food

Since 1900, our food system has also changed drastically. In 1900, 38% of the US labor force was farmers, providing widespread access to food; in the 2010 census, less than 1% of the population self-reported as farmers (EPA, 2014; Growing a Nation, 2014). This is due to the industrialization of the farming process: characterized by routinization, mechanization, standardization, and consolidation of farming practices (John Hopkins Center for a Livable Future, 2010). These changes have been so drastic, that researchers at Johns Hopkins stated, "during this brief period, the food system has undergone a greater transformation that it had experienced during the previous 10,000 years," (John Hopkins Center for a Livable Future, 2010). This industrialization has increased productivity, but also drastically changed American eating habits, which are much more reliant on the staple crops of corn, soy, wheat, and processed versions of them. Today, the average US diet is about 70% processed foods (Ryssdal, 2013). Furthermore, due to the centralization of the system, the average distance from farm to fork in the US is 1,500 miles (Segal, 2010).

These changes have not come without consequences. In general, processed foods tend to be high in sugar and fat, so these compounds are making up more of US diets than ever. The numbers are quite staggering when compared a diet recommended by the USDA. The USDA says to use sweeteners and fats "sparingly," the only food group listed not to get a full daily serving (USDA, 2014). A 2000 study found that the average

American eats the equivalent of 52 teaspoons of added sugar per day, meaning sugar not naturally occurring in foods (Story et al., 2008). This is the equivalent of 152 pounds of added sugar annually. When adding in fats, the average US diet derives "close to 50% of calories from added sugars and fats," (Story et al. 262, 2008). The emphasis on cheap processed foods has come at the expense of fresh fruits and vegetables. From 1985-2000 fruits and vegetables "led all other food categories in retail price increases," (Story et al. 262, 2008).

Race and Food Access

Finally, the racial divide in access to fresh food must be addressed. While someone living in a low-income neighborhood had 75% the access to local supermarkets as a middle-income individual, race plays a much bigger factor. Controlling for income, African-American neighborhoods only had 52% the access to local supermarkets (Story et al., 2008). Furthermore, the introduction of a supermarket into an African-American neighborhood was found to increase the fruit and vegetable intake for African-American households 3 times more than the increase for other households, and African-Americans living in a census tract with a supermarket had a higher vegetable intake than white Americans (Morland et al., 2002).

Health Impacts of Food Deserts

Lack of supermarket access may not be a pressing issue unto itself; however, it has been shown to have direct health effects on the effected populations. A study commissioned by New York City found "a direct correlation between a lack of access to healthy foods and health risks including obesity," (Segal 197, 2010). A University of Michigan study backed this up, finding that "the highest levels of obesity (32%-40%)

were observed in census tracts with no supermarkets," leaving residents to either travel long distances for fresh food, or buy from bodegas and convenience stores (Segal 198, 2010). Obesity is closely tied to diabetes, which is another issue with food deserts. A study of African-Americans in Los Angeles County found that the cardiovascular disease death rate in food deserts was close to twice the national average (Lewis et al., 2011).

Although there are many studies showing links between food deserts and diet-based health problems, there is not a consensus on this correlation. A study published in the American Journal of Preventative Medicine in 2012 has been touted as a rebuttal to the notion that food access and weight are linked (Kolata, 2012). This study asked students to report their height, weight, and food within a mile and a half of their house. No connection between healthy food access and weight was found, however, the results were completely dependent on middle-school students accurately reporting their weight, and comprehensive lists of the food accessible from their home. Furthermore, it expanded the distance between the home and food an extra half mile past the USDA's food desert definition (Kolata, 2012). This is not to say that all studies opposing the obesity-food desert link are flawed; this was just a high profile example.

Diabetes and obesity are not the only two health impacts from a lack of access to healthy food. The New York City evaluation found "a lack of nutrition leads to further health problems, cognitive gaps, and unpromising trajectories," (Segal 197, 2010). A long-term study in Guatemala showed just how drastic this can be. From 1969-77 children in two villages were given dietary supplements, one more nutritious than the other (atole being the more nutritious). Then, from 2002-2004, researchers found many of the original participants as possible and gave them a questionnaire about their

economic activity. The children who were given the atole before the age of 3 were found to have earned 46% more money throughout the course of their adult lives than those given the less nutritious supplement (Hoddinott et al., 2008). Therefore, a serious case can be made that improved nutrition can help the economy by increasing worker productivity.

III. Food Deserts in Durham

Durham County is located in the piedmont of North Carolina, and home to approximately 280,000, residents (U.S. Census Bureau, 2014). It lies next to Raleigh, the North Carolina state capital, and Chapel Hill, which together form the Triangle region. 42.5% of the population is White, 38.5% is African-American, and 13.5% is Latino. Average annual per capita income is $28,000, slightly above the state average but below the national average (U.S. Census Bureau, 2014). The land is fertile and there is easy access to fresh water with several reservoirs in the area. Traditionally, tobacco farming made up a large section of the local economy. However, that industry has left and now Duke University and the Research Triangle make up a large portion of the economy, but the low-skill jobs that tobacco provided have not been replaced (Center on Globalization, Governance & Competitiveness, 2009). Even with such fertile land, today, 16.2% of Durham's population lives in classified food deserts, over 43,000 residents in total (USDA Food Access Research Atlas, 2014).

Food Deserts in Durham

Durham's food desert problem is escalating in scale. Figure 1 compares Durham's nine census tracts classified as food deserts, to the five food desert tracts in 2012, when

Parsons completed her report (Parsons, 2012; USDA Food Access Research Atlas, 2014). The largest desert, #4, did not exist two years ago; it was created by the closure of Lowes Food on North Miami Boulevard (Phillips, 2012). This closure added over 13,000 people to Durham's food desert residents. Furthermore, Deserts #2 and #3 have both grown since 2012. Desert #1 was the only one to shrink since 2012 (Parsons, 2012). Overall, these changes resulted in nearly 16,800 more people living in food deserts from 2012 to 2014 (US Census Bureau, 2014). Of Durham's food desert residents, 3,400 are children under the age of 5, 17% of Durham's children under age five. This means that those under age five, the age group where proper nutrition is most vital, have a greater chance of living in a food desert than a random Durham citizen.

Table 1. Demographics of Durham's Food Deserts (US Census Bureau, 2014).

Food Desert #	1	2	3	4	County Total
Census Tracts	1	3	2	3	60
Population	6,736	13,107	10,165	13,213	267,587
Population Density (per acre)	2.97	3.55	4.94	3.05	1.46
% Minority	85.91%	91.00%	56.73%	64.85%	53.56%
% <10 years old	17.84%	15.43%	12.21%	14.45%	13.59%
Per Capita Income ($)	16,447	17,889	20,565	28,481	27,988
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% Minority	85.91%	91.00%	56.73%	64.85%	53.56%
% <10 years old	17.84%	15.43%	12.21%	14.45%	13.59%
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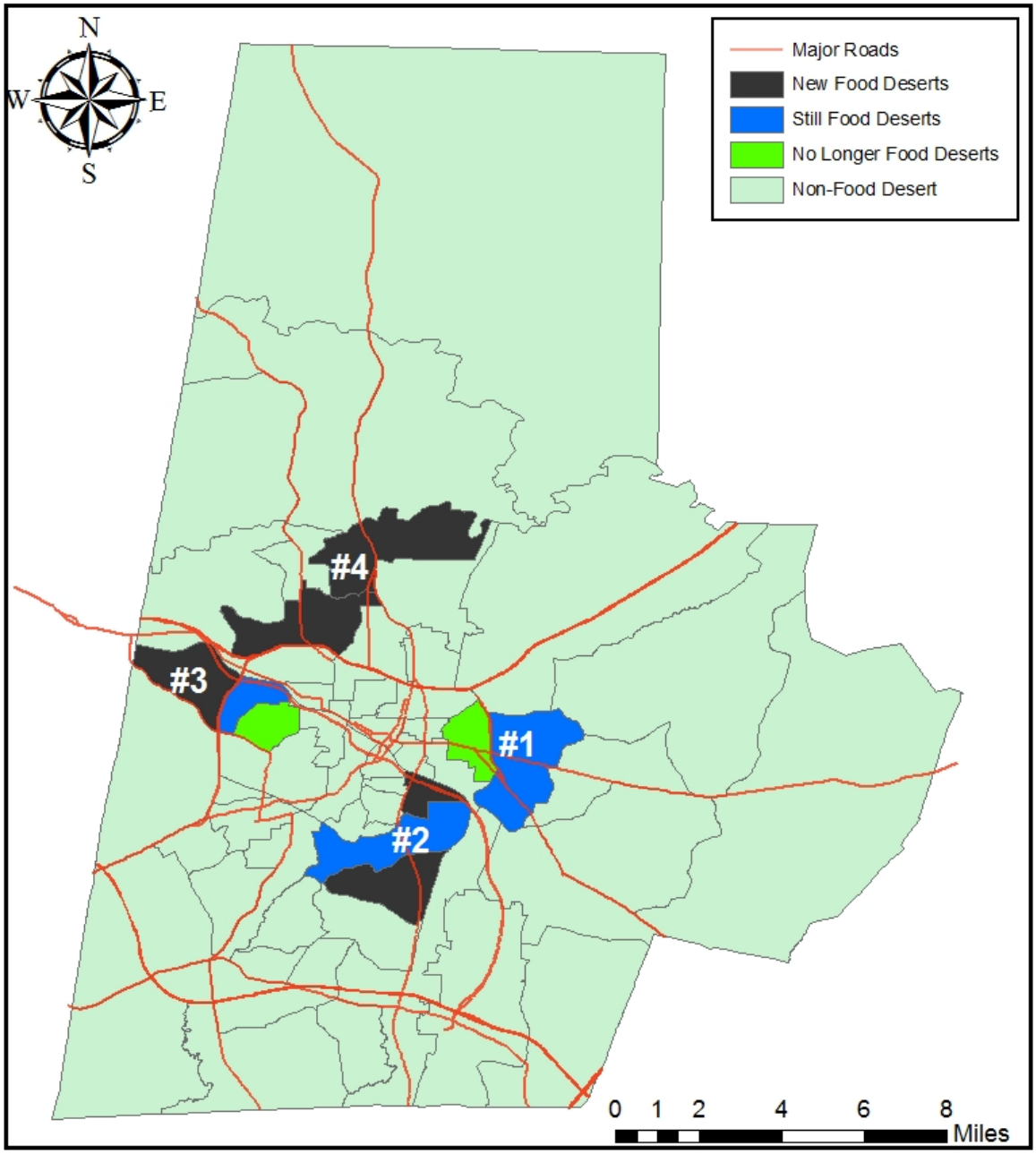

Figure 1: 2014 food deserts in Durham County compared to data from 2012 (USDA Food Access Research Atlas, 2014; Parsons, 2012).

Low Density

Durham is a very suburban city, with an average population density of 2,370 people per square mile, compared to the US average for large cities of 3,245 people per square mile (US Census Bureau, 2014; Cox, 2012). Furthermore, new growth into the city is occurring on the outskirts. Figure 2 below shows population growth in Durham from 2000-2009. It shows that the city center of Durham actually lost population throughout those years, while the city itself grew by over 37,000 residents (City of Durham, 2014). Almost all of the growth in Durham has occurred on the city outskirts, south of the city center.

Eating Habits and Health

Durham's eating habits are reflected in its health statistics. Of the adults in Durham, 26.4% are obese and another 32.9% are overweight (Partnership for a Healthy Durham, 2012). Furthermore, 7.0% have diabetes, with 8.9% showing warning signs of pre-diabetes (Partnership for a Healthy Durham, 2012). This has created a public health disaster, with four of the six leading causes of death in Durham being weight related (heart disease, strokes, chronic respiratory disease, and diabetes). The two others in the top six were, "all cancer" and "all other unintentional injuries," (Partnership for a Healthy Durham, 2012). In 2011, there were 686 fatalities from these weight-related diseases (Partnership for a Healthy Durham, 2012). Thankfully, these mortality rates are on the decline. However, treating diabetes alone each year costs Durham over $190 million[1] (Durham Health Innovations, n.d.).

[1] This figure was calculated for Durham County based on data for North Carolina in 2006. In 2006, $5.3 billion of economic damage occurred from hospital bills as well as lost

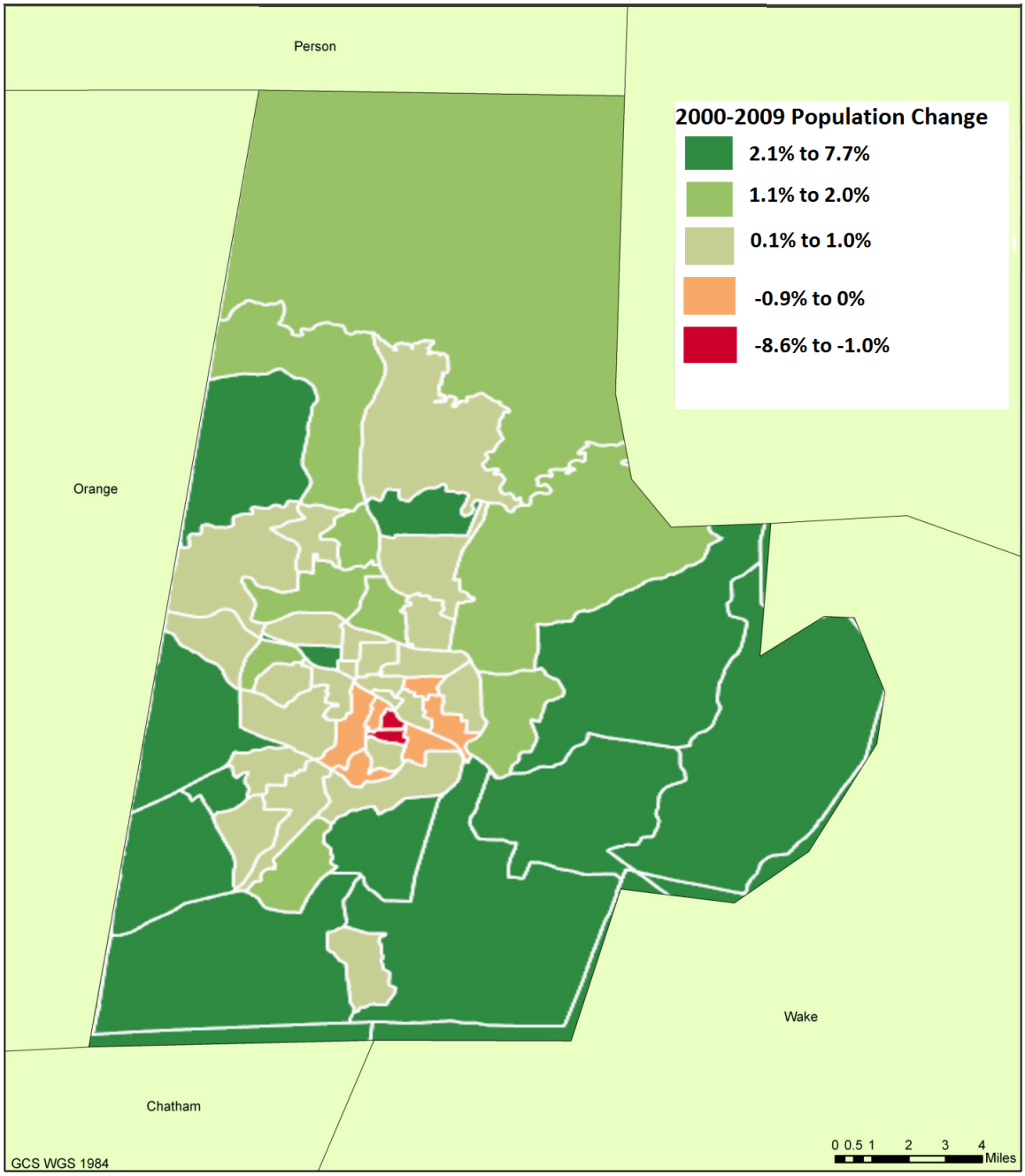

Figure 2: Change in Population Density for Durham County, 2000-2009 (City of Durham, 2014).

economic productivity. This number was then applied to Durham based on population, Durham's higher diabetes rates, and finally adjusted for inflation.

While, mortality rates from weight-related diseases are declining, obesity and diabetes rates are increasing in Durham. In 2006, only 23.5% of Durham's adults were obese (Partnership for a Healthy Durham, 2006). In 2008, the diabetes rate was just over 6% (Durham County, 2012). These trends are not likely to get better. Out of children enrolling in Kindergarten in 2008, 18% were already obese or overweight. Furthermore, Durham's youth is more likely to live in food deserts, restricting their access to fresh produce. One factor in these rate increases is a decrease in vegetable consumption. In 2001, 31% of Durham residents reported meeting the suggested number of vegetable servings daily. By 2011, this was down to 19% (Partnership for a Healthy Durham, 2013).

Race and Food Access in Durham

The links between race and food access hold true in Durham. Out of the 43,000 residents of Durham's food deserts, only 11,200 are white (US Census Bureau, 2014). Comparatively, nearly 24,000 are black, and over 7,000 are Latino. Given the smaller populations of Durham's black and Latino communities, a random resident of either race would have nearly double the probability of living in a food desert than a random white resident. 11% of Durham's white population lives in food deserts, compared to 19.2% and 20.2% of the black and Latino communities, respectively.

Examining Figure 3, below, we can clearly see that race plays a large role in predicting food desert's residents. Of the nine census tracts defined as food deserts, five of them have a non-white population above 80%. Another two census tracts have non-white populations of 69%. This difference between races can also be seen in health data. In Durham, 52% of people with diabetes are black, even though they are under 38.5% of the population (Durham Health Innovations, n.d.). Furthermore, the mortality rate is

much higher for black diabetes patients than white ones, with 47.8 and 18.2 deaths per 100,000 people respectively (Durham Health Innovations, n.d.).

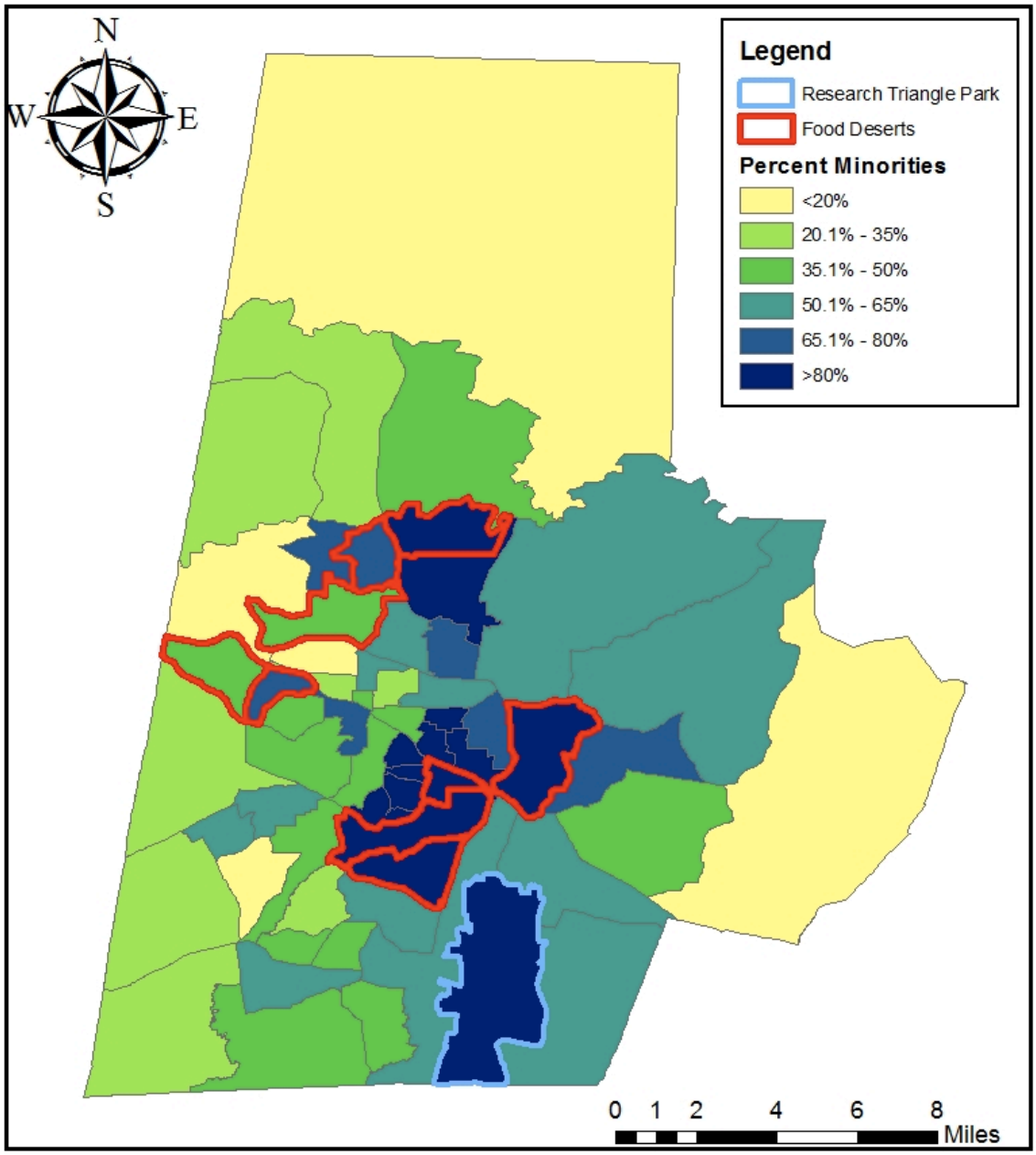

Figure 3: Percentage of minority populations in Durham's census tracts (US Census Bureau, 2014).

IV. Policy Descriptions

Policy 1: Status Quo

Durham City and County do very little to promote healthy food access in food deserts. The most relevant initiatives are part of the Statewide Healthy NC 2020 program, which set targets concerning 13 health problems, such as tobacco use, environmental quality, injuries from crime, and others (NC Department of Public Health, n.d.). Three of the objectives are relevant to this project. First, the physical activity and nutrition goal aims to increase the number of people who get the recommended daily amounts of vegetable intake and exercise. The second, the chronic disease goal aims to reduce the number of mortalities from heart disease, and the percentage of residents with diabetes. The final relevant goal is reducing the number of people who are not overweight or obese, although the target of 38.1% does not seem very ambitious (NC Department of Public Health, n.d.). Of these goals, the only ones not being met today are the physical activity targets, and the number of people consuming enough vegetables. The target, of 29.3% of adults consuming five or more servings of vegetables daily, was actually met in 2001 when 31% of Durham's adults got enough vegetables. However, this number has steadily declined to 19% today (Partnership for a Healthy Durham, 2013). Surprisingly, Durham meets the obesity goal, even though it has higher mortality rates from obesity than North Carolina averages (Partnership for a Healthy Durham, 2012).

While most of the initiatives to achieve these health goals involve more encouraging active lifestyles and health screenings, three projects involve food access. First is the Healthy Aisle Program, which encourages grocery stores to place healthier snacking options (fruits, vegetables, nuts, and low-fat snacks) next to the cashiers rather

than the usual candy (Upchurch, 2013). The other two projects improve access to local produce, making them more in line with the goals of this report. One is a collaboration with the Veggie Van, allowing them to operate a CSA from Durham's Human Services Building. The other is helping the Durham Farmers' Market set up an EBT card reader to enable food stamp recipients to use their benefits at the market (Partnership for a Healthy Durham, 2013). This card reader is expected to be operational in time for their spring 2014 market schedule.

In the private sector, there are several businesses that provide locally sourced produce to Durham. Currently six farmers' markets and stands operate in Durham, as well as the Lo-Mo Market, a food truck selling local produce. Figure 4, below, shows the locations of these vendors. There are also multiple CSAs offering weekly food box subscriptions. Finally, free services exist like the Durham Food Bank and the interfaith food shuttle, which receive food that would have otherwise gone to waste and distribute it to low-income communities. Although there are many vendors of local produce, not many are located in food deserts: one market (a flea market with several food stands), and four of Lo-Mo Market stops. Of these five possible locations for local produce, each is only available one day a week. Finally, of all the markets in Durham, only two accept EBT cards; neither of those markets are in food deserts.

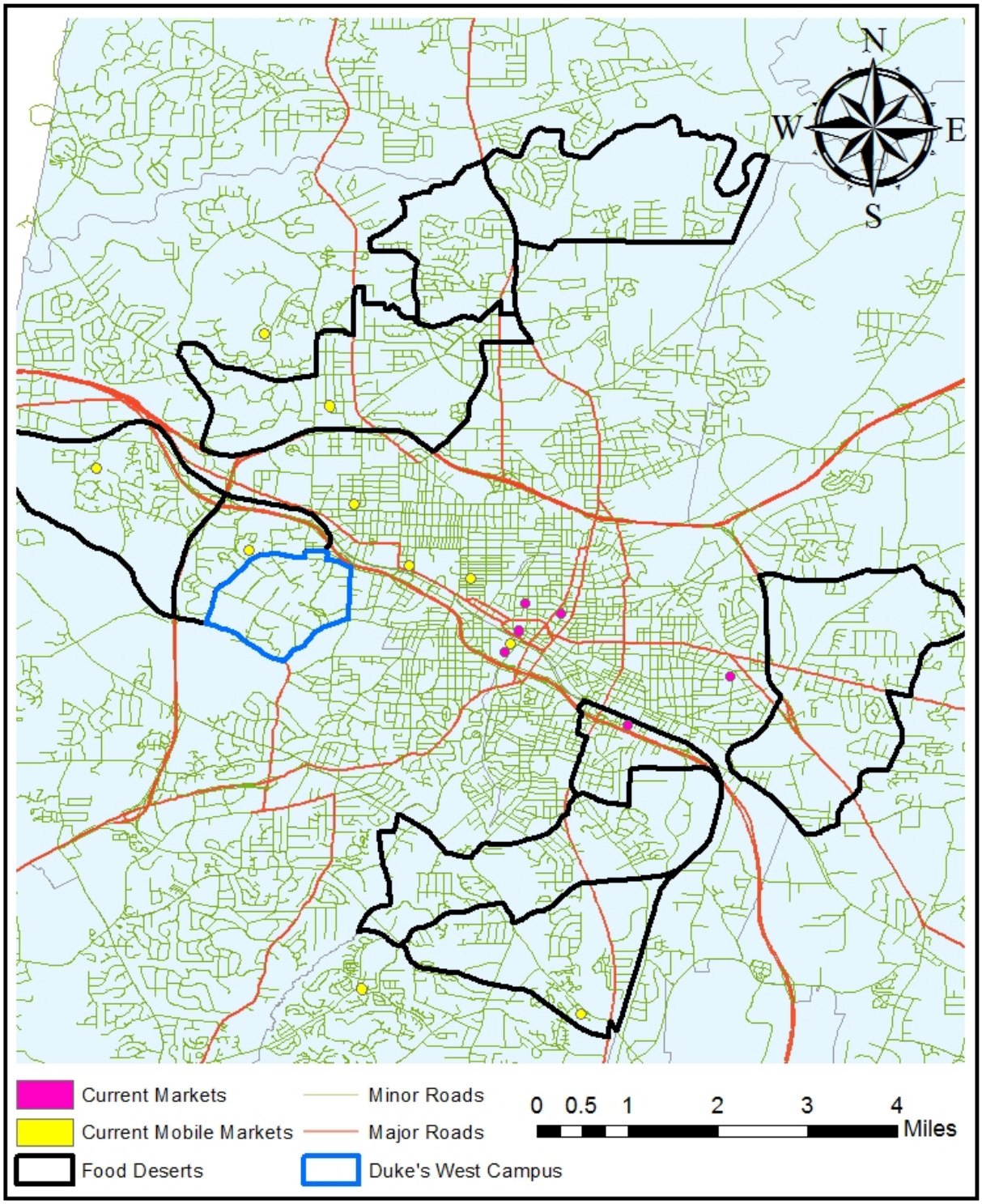

Figure 4: Current farmers' markets and mobile markets in Durham, as well as food desert locations (North Carolina Department of Public Health, 2013).

Policy 2: EBT Incentive's at Markets

This policy would be modeled after New York City's Health Bucks Program, which was established in 2005 with the duel goal of increasing fresh produce access in food deserts and supporting farmers' markets (Payne et al., 2013). The program provided two incentives for shopping at farmers' markets: a small coupon to encourage new attendance at markets, and second a coupon to encourage more EBT spending at markets and supplement the cost. The first coupon was a $2 benefit attached to EBT cards, intended to bring in new customers for local markets. To start out, this program did not have high participation rates, with only 24% of coupons redeemed in 2005 (Payne et al., 2013). Then in 2007, $2 paper coupons were given to community organizations in food deserts to distribute to local residents. This greatly expanded the program, raising awareness and redemption rates to 69% in 2010. Furthermore, it increased knowledge of the $2 coupons attached to EBT cards, increasing their redemption as well. The second coupon was an additional $2 bonus for every $5 spent on an EBT card at a farmers' market (Payne et al., 2013).

Payne et al., (2013) conducted an analysis of the program's effects by tracking the coupons through barcodes, and interviewing market vendors and managers. Of the vendors surveyed, 70% said they noticed more new customers shopping, and 95% noticed an increase in repeat customers; for market managers the numbers were 100% and 95% respectively (Payne et al., 2013). They also found that markets accepting EBT had a higher demand for vendor participation. The program was not without its faults. 59% of market managers said that the program slowed down market activity, by increasing more complicated EBT transactions (Payne et al., 2013). Furthermore, it added

an extra burden on the vendors, as they have to mail in coupons for redemption, and EBT revenue is also delayed.

Supplementing WIC checks is another method that has been shown to increase farmers' market attendance, sales, and vegetable intake. McCormick et al., (2010), examined multiple studies on the effect of farmers' market benefit programs on vegetable intake. The largest study cited spanned thirty states in 2002, sampling 24,800 WIC recipients and 2,561 famers (McCormick et al., 2010). The states attached an $18.50 coupon to WIC benefits to be redeemed at farmer's markets. They found that 43% of recipient had never been to a farmers' market, yet 73% planned to return, even without a coupon. 53% of the recipients learned new ways to prepare fresh produce, and long-term vegetable consumption increased 5% (McCormick et al., 2010). In another study from Los Angeles, researches distributed a $10 WIC coupon redeemable at either a farmers' market or grocery store. They found that, on average, those who redeemed the coupon at farmers' markets vegetable consumption increased by 1.4 servings/1000kcal. Those who redeemed coupons at grocery stores only increased vegetable consumption by 0.8 servings/kcal (McCormick et al., 2010).

Policy 3: Establish New Farmers' Markets

With last year's policy change in Durham, new farmers' markets are allowed in many new regions of the city. Markets are allowed in any non-residential zone of the city, and within residential zones, "on property used as an educational facility, place of worship, park, community service facility, or government facility," (Durham City Council, §5.5.2, 2013). This amendment to Durham's Unified Development Ordinance allows new farmer's markets to apply for temporary use permits on an annual basis. The

City Council could facilitate the introduction on new markets in food deserts by minimizing the application process and regulatory requirements on markets. First, fees for temporary permit applications could be waived for vendors serving food deserts. Second, permits could be granted for longer than one-year terms. Third, the application process mandates a neighborhood meeting to discuss any project. This could be waived as well in order to expedite the process (Durham City Council, §5.5.2, 2013). Finally, Durham could help with public relations and promotions for new markets in order to help increase attendance rates by the surrounding communities.

Health centers have been shown to be effective locations for markets (Freedman et al., 2013). They are generally centrally located, easily accessible to those without cars, in low-income areas, and the people there are concerned about their health. One study, by Freedman et al. (2013) gave a $50 voucher to diabetes patients at a health center, available for redemption at a vendor outside the clinic. Then their dietary consumption was tracked as part of their diabetes treatment, so data was available before and after the study (Freedman et al., 2013). While vouchers were available, daily fruit and vegetable consumption increased by 1.6 servings. More importantly, lasting effects were seen after benefits expired, as average daily fruit and vegetable servings remained 0.5 higher than the baseline average (Freedman et al., 2013).

Figures 5, 6, 7, and 8, depict potential sites for new markets in each of Durham's food deserts. The site analyses will be applied both to fixed and mobile markets. The locations shown are places of worship and health centers near Durham's food deserts, which would meet the criteria for market placement. It also shows bus routes and roads in the food desert, in order to display the level of accessibility. Locations that are near

intersections and dense grids, as well as bus stops are preferable as they are the most accessible. Furthermore, health centers should be targeted during the week, and places of worship during the weekend, in order to maximize potential customers.

Seen in Figure 5, food desert #1's best location for a market is in its southwest corner. It is near the intersection of multiple bus lines, has a tightly packed grid implying a denser population, and there are two places of worship that it can serve on Sundays. No other location in this food desert is along a bus stop, so this is by far the best option. This food desert has the lowest population, however it should be targeted based on the priority of increasing equity. It has the highest proportion of children under age ten of any food desert, and only has a white population of 14%.

Food desert #2, in Figure 6 has multiple good locations, due to dense street configuration, bus lines, and many places of worship. With a 9% white population, improving food access here would address structural inequality between races. Several locations appear to be good spots for markets. Both health centers are along bus lines, and while one is just outside the food desert, it is easily accessible to residents of the food desert. Markets at each center on different days of the week would improve access for different areas of the desert. Two other viable locations are near the cluster of churches on the northern and western edge of the desert. Both have dense street clusters and multiple bus routes, making them good weekend locations. Finally, the Lo-Mo market stops at the church at the southeastern edge of the desert, so there is some access for that section of the desert.

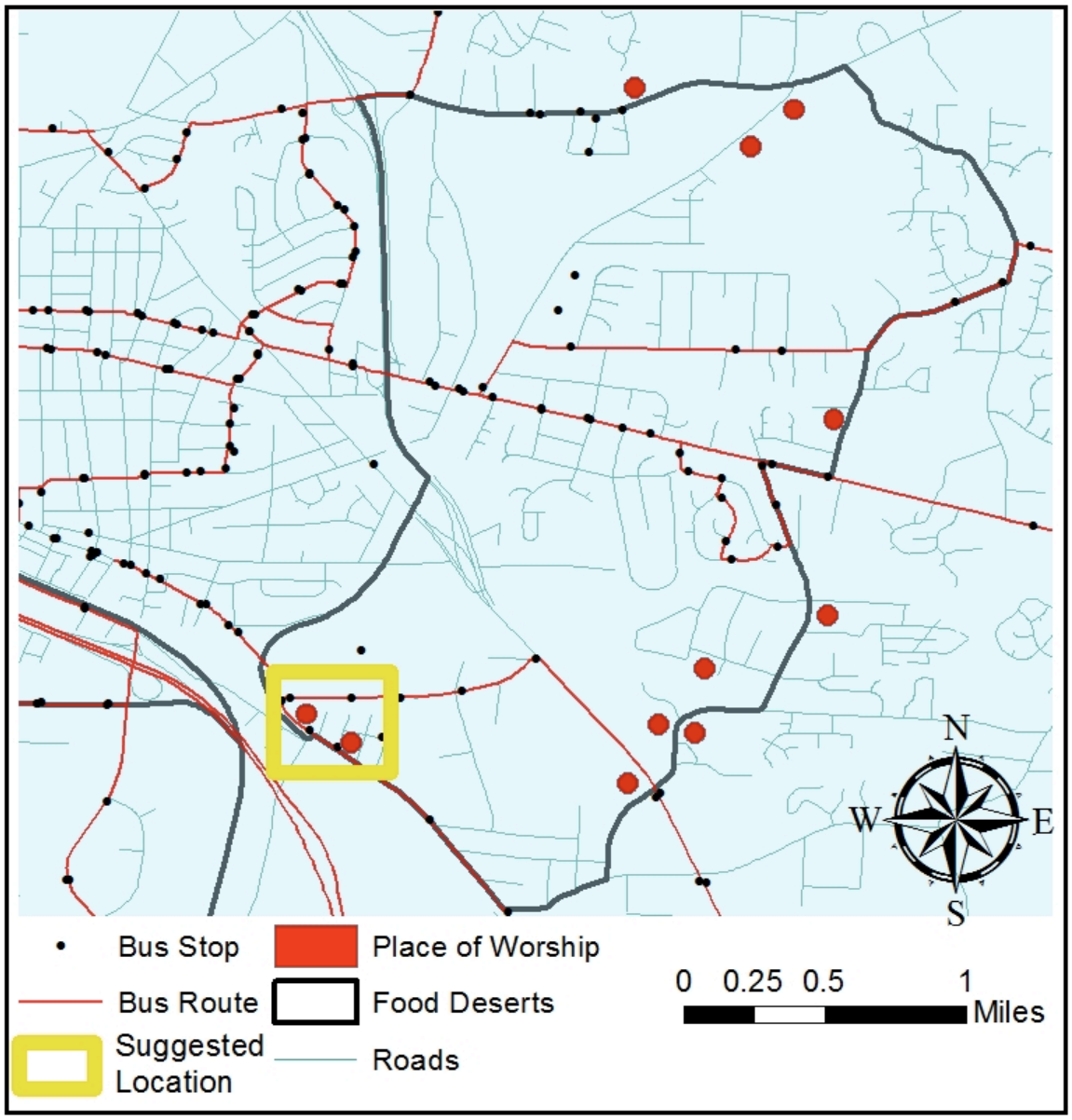

Figure 5: Recommended market sites in food desert #1.

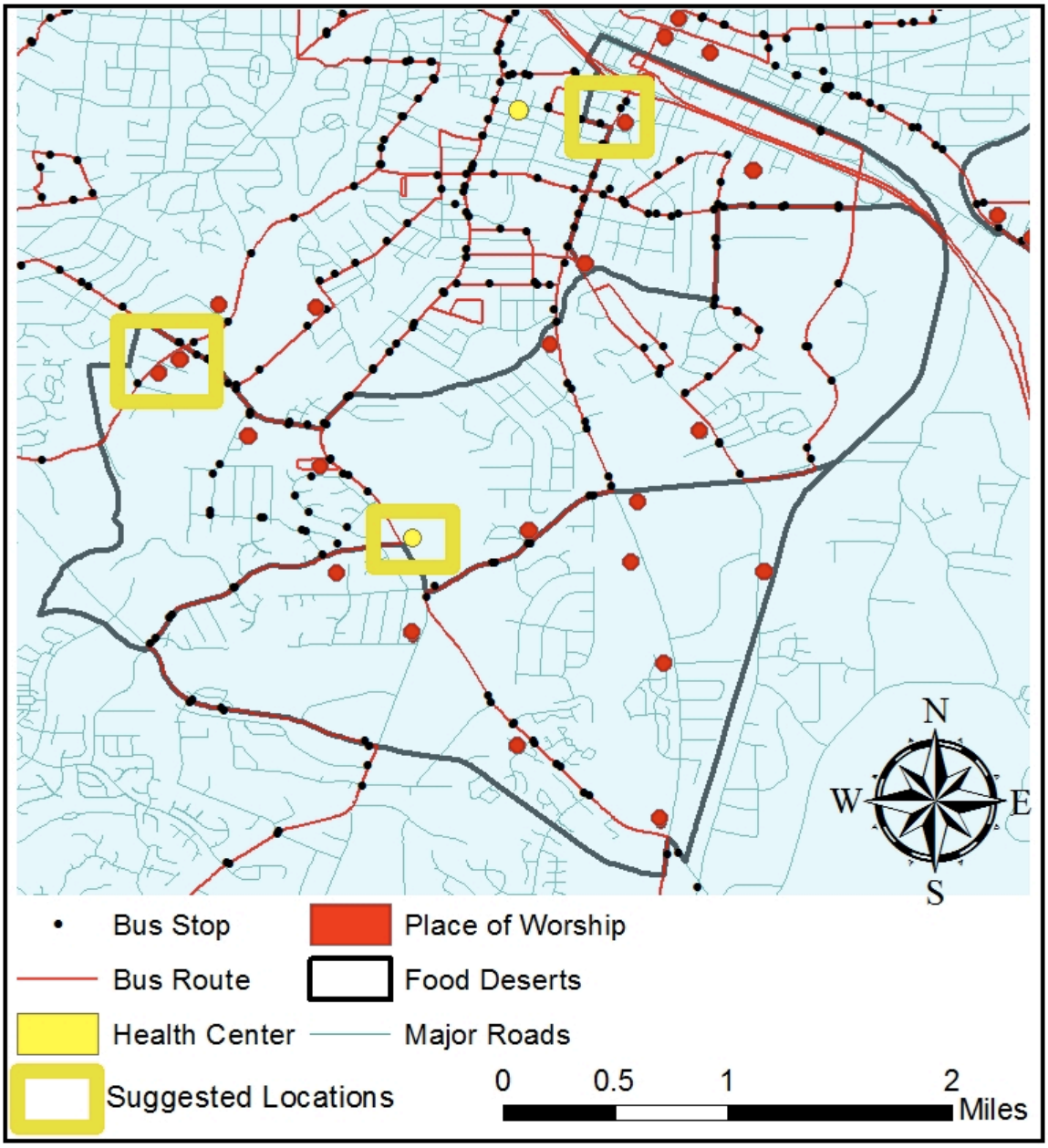

Figure 6: Recommended market sites in food desert #2.

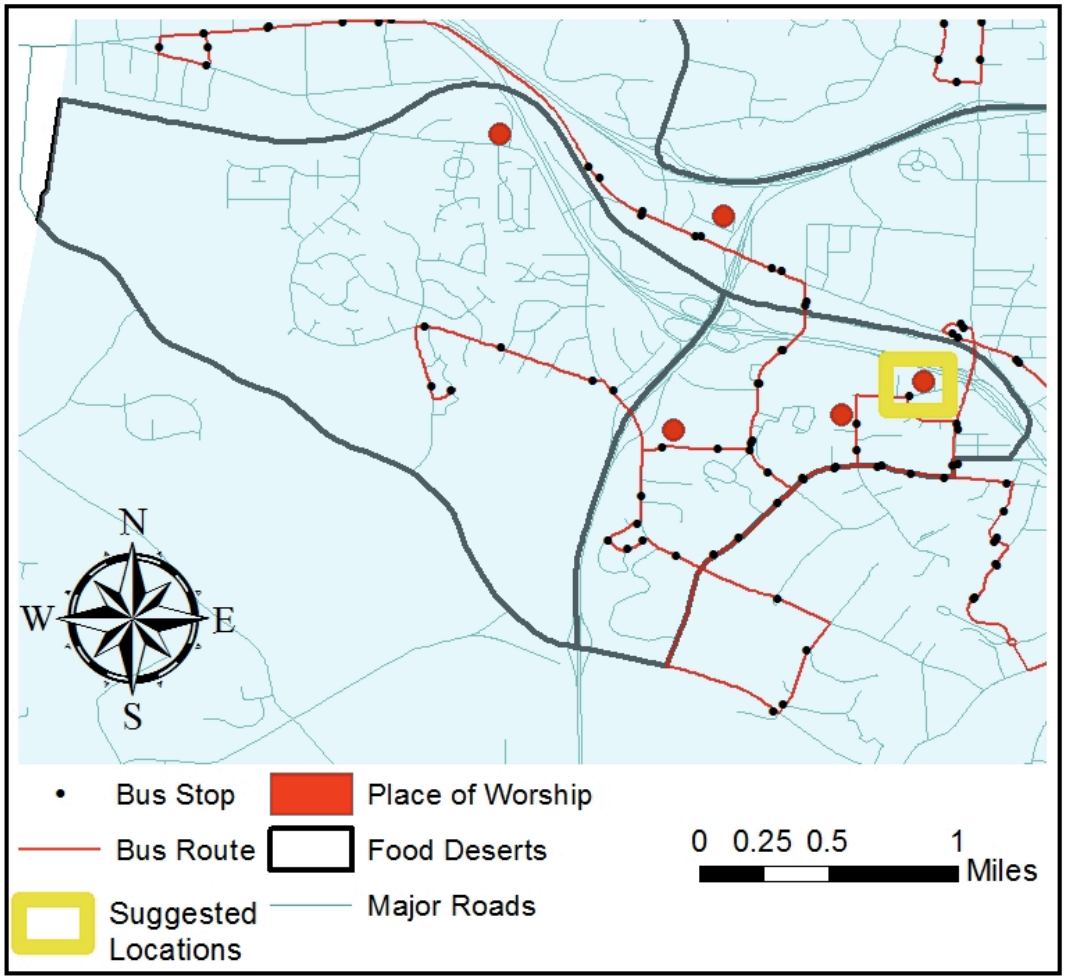

Figure 7: Recommended market sites in food desert #3.

Desert #3 is a strong option for markets, as it has the highest population density of any of Durham's food deserts. However, it also has the lowest proportion of children and minorities of any of Durham's food deserts. Therefore, while it may be an attractive option for private sector action, municipal policy should not prioritize action in this desert. This is compounded by the fact that the Lo-Mo market already operates at two locations in this desert. That said, there are good options for markets. The best ones appear to be on the eastern portion or the desert, where there are two places of worship, in addition to dense street patterns and multiple bus lines.

Food desert #4, below, has many good options for market locations. It may be the most appealing to private sector actors, as it has the highest population and per capita income of any of Durham's food deserts (US Census Bureau, 2014). Three locations stand out as strong possibilities, all in different sections of the desert. One could be a weekday market, located at either of the health centers in the middle of the desert. Both are near bus lines and have dense street configuration. While both centers are just outside the food desert, they would still help improve access. Another possibility is at the church in the center of the desert's southern portion, which is along a bus line and surrounded on all sides by a tightly packed grid. The Lo-Mo market stops there on Tuesday evenings; however, given that it is somewhat removed from the other good locations, and in the center of the most populated census tract in desert #4, a weekend market there would be a good location. The final suggested location is in the northern section of the desert, along the bus line. It is right between two dense grids, and sits on a major road, so it has good accessibility.

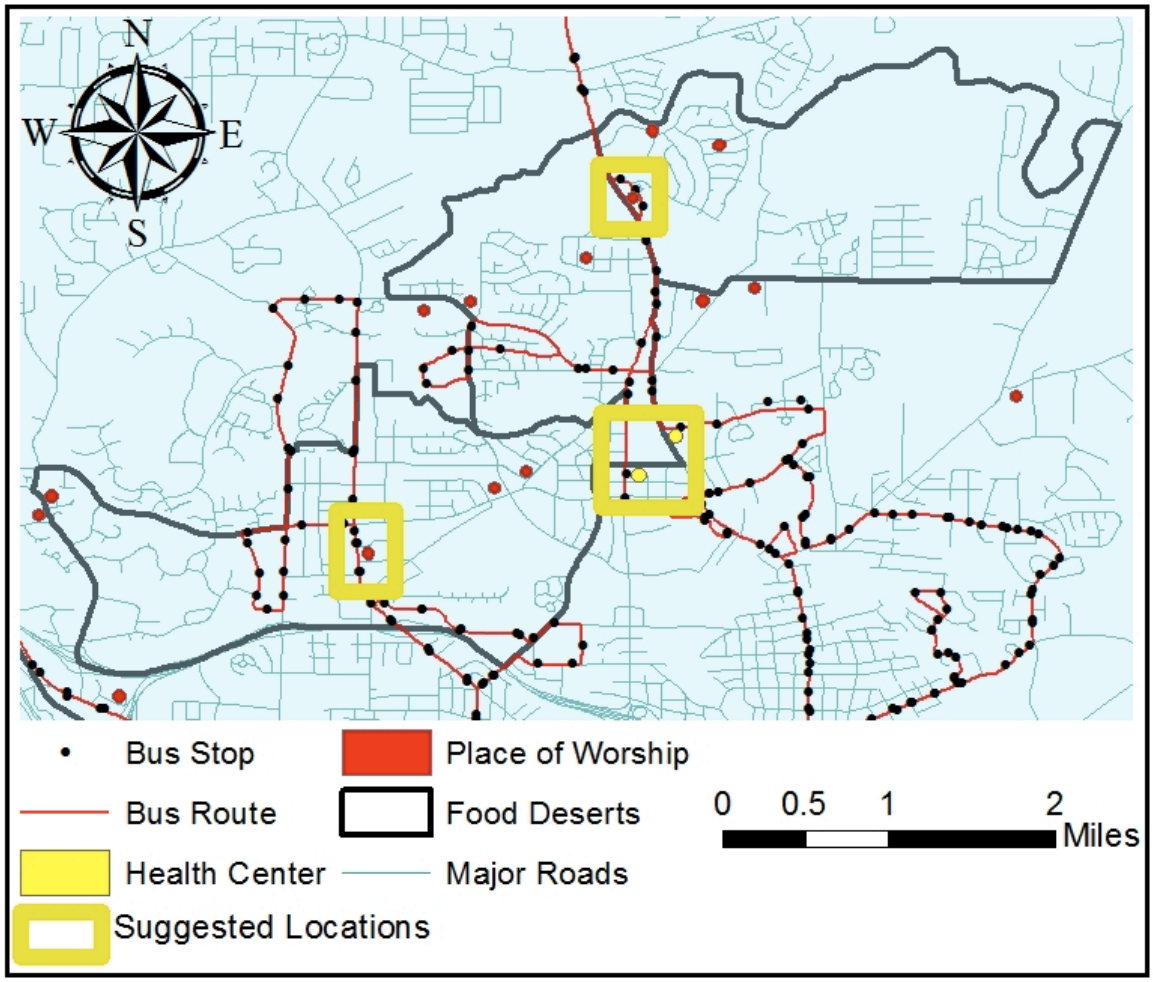

Figure 8: Potential market sites in food desert #4.

Policy 4: Mobile Markets

Mobile markets have been shown to be an effective and low-cost way to get fruits and vegetables into food deserts. In 2008, New York City began its Green Cart Program, as a way to increase access to fresh produce in food deserts. The program expedites the vendor approval process for vendors selling fruits and vegetables in the City's food deserts (Black, 2012). It was seen as a low-cost and flexible way to provide fresh produce throughout the city, costing only $3,000 to begin operations with about 500 permits distributed so far (Black, 2012). Since its inception, 90 vendors have been equipped with

EBT card readers (LMT Illumination Fund, 2014). One such vendor estimated his sales have increased 20% since he began accepting EBT (Black, 2012).

The program's flexibility is one of its best attributes. The lack of infrastructure required allows vendors to move locations and tailor their offerings to the diverse neighborhoods of the city. In the aftermath of Hurricane Sandy, the Illumination Fund gave a small grant to Green Carts to provide provisions to impacted neighborhoods. Furthermore, City Harvest has teamed up with the Green Carts Association in order to conduct cooking demonstrations, and distribute nutritional information and recipes at some of the more established carts (The Laurie M. Tisch Illumination Fund, n.d.). It is estimated that 900 jobs have been created since the program began. Finally, a survey of New Yorkers found the number of adults who ate no fruits or vegetables the day before the survey has decreased from 19% to 15% from 2004-2010 (Black, 2012). The program does have some resistance. A survey of vendors by City Limit, found that the average vendor only made $62 in profits daily (New York Association of Grocery Stores, n.d.). This makes vendor some of the poorest people in America, so while it has increased access to food, more profitable business structures should be developed.

In Durham, similar mobile markets could be established in two different ways. First, borrowing from the NYC Green Cart program, small-scale markets using folding tables could be set up with only a few vendors. This would allow vendors to move depending on the popularity of certain locations. For example, tables could be set up outside of a church within a food desert on Sundays. The other option would expand on the Lo-Mo Market example, and establish a food truck carrying fresh produce. The locations discussed in the previous section would apply to the mobile markets as well.

V. Policy Analysis

Policies will be evaluated based on four criteria: (1) expected costs and benefits, (2) actors required for implementation and feasibility, (3) affected populations and equity concerns, and (4) improvability and adaptability of the policy.

Cost-benefit analysis will be used to evaluate and quantify the economic consequences of each policy. First, a baseline status quo cost will be calculated from several sources, based on trends of higher disease and mortality rates in food deserts (Treuhaft and Karpyn, 2010; Durham Health Innovations, n.d.). After this baseline cost is established, benefits from the three policy alternatives will come from expected reductions in these trends, as well as the increased economic benefits derived from purchasing from local sources (Sonntag, 2008; Martinez, 2008). Any expenditure by the city will count as an administrative cost of a policy. The majority of benefits will come from changing diets and health outcomes.

This analysis will assume policies are implemented for five-year intervals. Thus, the costs and benefits will represent the full value of these five years, using a discount rate of 5% to calculate a net present value. Administrative costs will accrue at the beginning of each year. Benefits, as well as the cost of higher disease and mortality rates will accrue at the end each year. Given the long timeframe over which health changes occur, it is likely that benefits may not accrue for several years and then exceed expectations as trends become widespread. This could lead to a slight exaggeration in net present value, as benefits will accrue in later years, meaning they need to be discounted further. However, given the lack of data addressing this time lag in relation to health outcomes, annual values will be calculated based on average expected values.

The implementation and feasibility of each policy will examine the specifics of what it will take to get each policy up and running. The number of private businesses required for implementation will be considered, however the legislation required from City Council will be the priority for this section. An analysis by the Municipal Research & Services Center of Washington (1999), examined the characteristics of successful municipal policies. They found three major factors contributing to the likelihood of a policy being passed: issue specific information, past action on the issue, and cost considerations (Municipal Research & Services Center of Washington, 1999). It will be assumed that this report will provide the issue specific information, as it details the effects of food deserts, policy solutions, and benefits of implementing them. As for past action, based on last years' legislation permitting more local farming and markets, as well as health initiatives such as the Diabetes Awareness Day and work for Healthy NC 2020, past City Council actions have addressed these issues. Therefore, the cost of a policy will be the major factor in municipal implementation.

Based on interviews with market managers and local farmers, there is ample excess supply of locally sourced food around Durham. Each year both of Durham's farmers' markets receive too many vendor applications, and must reject several vendors. Also, in interviews farmers indicated that they would be able to increase supply if there was sufficient demand, and markets in which to sell this new produce. Therefore, the capability of local businesses to meet increased demand will be assumed.

The equity considerations will focus on who the policies affect. Three populations in particular will be given priority in policy recommendations: children, minorities, and low-income residents. Proper nutrition in children has been shown to affect health

outcomes and future earnings throughout life. Thus, policies that provide access to younger populations will have higher benefits and should receive stronger consideration. Given the strong links between race and food access, increasing access to fresh produce in minority neighborhoods should also be considered a priority. Finally, given that cost was identified as the major barrier to a healthy diet, low-income neighborhoods should be prioritized (Parsons, 2012). Furthermore, these are areas that are less likely to be targeted by businesses, so public policy should work to make serving these neighborhoods more enticing.

The improvability and adaptability of each policy will be evaluated based on the ability of administrators and business owners to modify implementation after the policy is in place. This will help demonstrate how flexible aspects of the policy are to adapt to circumstances encountered upon implementation. In order to assess this, minimum time commitments, location commitments, and rigidity of policy administration will be evaluated.

Policy 1: Status Quo

Costs and Benefits

As stated earlier in this report, 7% of Durham suffers from diabetes, which costs the county $190 million annually for medical treatment and lost economic activity during this treatment (Durham Health Innovations, n.d.; Partnership for a Healthy Durham, 2012). Per diabetes case, the average annual cost is $10,154. Furthermore, in 2011 there were 686 deaths from preventable, weight-related diseases in Durham (Partnership for a Healthy Durham, 2013). In order to determine how much of these annual costs can be

attributed to food deserts, several steps were taken. First, studies in New York and California have shown that obesity and diabetes levels in food deserts can be 20% higher than in healthy food environments (Treuhaft and Karpyn, 2010). Next, applying this higher disease rate to Durham's diabetes cases and mortality rates, we can find the excess annual deaths and diabetes cases causes by food deserts: 21.7 annual excess deaths and 585.7 excess diabetes cases. Finally, by applying the cost per diabetes case ($10,154) and the US value of a statistical life ($7.9 million), we find that each year food deserts cost the city of Durham $176,670,000. Over the five-year time period of this policy, the net present value is -$765,886,000 in 2014 dollars.

Implementation and Feasibility

Given that this policy is the current reality in Durham, no action for implementation.

Table 2: Breakdown for calculation of annual cost of food deserts in Durham.

Category	Value
Total Diabetes Cases	18,700
Annual Cost of Treating Diabetes	$190 million
Cost/Diabetes Case	$10,154
Excess Diabetes Cases in Food Deserts	585.7
Deaths from preventable, weight-related disease	686
Excess Deaths in Food Deserts	21.6
Value of a Statistical Life	$7.9 million
Total Cost	**$176,670,000**

Affected Populations and Equity Concerns

Durham's food deserts have higher rates of children under 10, minorities, and low-income residents than the county as a whole (US Census Bureau, 2014). While the

city is 13.6% children under 10, 14.8% of food desert residents are under 10. As for minorities (the non-white population), they make up 53.6% of Durham's population, but are 74.2% of the food desert population. Finally, the average per capita income in food deserts is $21,500, $6,500 less than the overall per capita income. Thus, the status quo has very serious equity concerns.

Improvability and Adaptability

The status quo has very few policies on which to adapt and improve. The Healthy Aisles is the only ongoing project through which Durham promotes healthy diets (Upchurch, 2013). While this is a good start, given the overall lack of action, the status quo has to be seen as a rigid policy.

Policy 2: EBT and WIC Benefits

Costs and Benefits

This policy would have some overhead and institutional costs, including staff to run the program, print and distribute coupons, and process coupons to return value to the farmers. However, the staff salary would dominate these administrative costs, as the cost of printing and delivering the coupons would be very small. Since the staff member would largely be in charge of processing coupons, a highly skilled individual is not required. Therefore, $60,000 annually could be allocated to cover their annual salary, as well as the very small cost of managing coupons.

Besides administration, the cost of financing the coupons is the policy's major expense. 10% of the residents in Durham are on food stamps, and 16.2% live in food deserts (Bloch et al., 2009; USDA Food Access Research Atlas, 2014). The numbers of

WIC recipients could not be found, as it is constantly changing based on age. However, there are 3,400 children under 5 in Durham's food deserts (US Census Bureau, 2014). Assuming that all of these people got a $2 initial coupon, which ignores the significant double counting, $146,700 would be distributed. Maximum redemption rates in New York peaked at 69%, so the actual figure would be closer to $101,000 (Payne et al., 2013). The cost of the incentive coupon is harder to determine, because it is based on shopping behavior, which has not begun yet. However, in New York, this coupon was 40% the cost of the population-based coupons. In Durham, this would cost just under $40,500 annually. Therefore, this program could be implemented for $201,500 annually.

The benefits of this program would go directly to the coupon recipients and the small, local businesses where coupons are redeemed. The benefits are quantified based on studies that have shown that spending on locally sourced products has a significantly greater impact on community well-being than spending at chain stores. A USDA study from 2010 found that every dollar spent at farmers markets created an additional $0.58 spent locally, 76% more than chain stores (Martinez, 2010). A similar report from Seattle found that each dollar spent at a farmers market created an additional $0.62 spent locally (Sonntag, 2008). Taking the average of these two studies, introducing $141,500 into farmers' market spending, would generate an additional $84,900 of spending around Durham, through suppliers and other businesses that vendors patronize. Some of this can be expected return to the city through sales tax. The added health benefits of increased produce consumption would be on top of this. The health benefits for this policy will be considered as part of the next two policies, which actually make the food accessible in

food deserts. Thus, the five-year net present value for this policy is -$548,400 in 2014 dollars.

Implementation and Feasibility

This policy would require an act of the City Council to adopt, as it increases city spending. However, for the 2013-2014 fiscal year, Durham has a budget of over $381 million. Adding in a $201,500 policy would only be a 0.053% increase in annual spending, so it should not be seen as a major public expense or burden on the budget. That said, it is the most costly on public finances of all the policies. Comprehensive implementation would also require all markets to accept EBT and WIC cards. However, there are several technologies that accept those forms of payment at no extra cost, so this is not a large obstacle. Finally, ensuring widespread knowledge of this policy would be a major step towards its success, as Parsons, 2012, identified a lack of familiarity with benefit programs as a major barrier to food access.

Affected Populations and Equity Concerns

Providing EBT and WIC incentives to be used at farmers' markets specifically targets two of the priority populations, children and low-income residents. Therefore, it would have strong and positive equity effects. Furthermore, almost all of the money spent through this policy would go directly to local farmers and businesses, supporting the local economy.

Improvability and Adaptability

As the case study of New York shows, this policy can be adapted and improved based on early experiences. Different distribution methods can be tested in order to

maximize redemption rates. Furthermore, different benefit values can be tested in order to see what incentives cause the largest impact on sales. If redemption rates are low, higher initial coupons can be used. If sales are not as high as expected, larger multipliers can be added to purchases.

Policy 3: New Farmers' Markets

Costs and Benefits

The costs of this policy would mostly be borne by the private sector. If Durham gave institutional support, through waived fees, faster application processing, and some assistance with marketing, it would still cost very little. Application fees are $75, and since temporary permits only last a year, this is an annual cost. Spending to help promote the markets would be the primary expense. However, if several markets are established, they can likely be promoted together to reduce costs. Overall, marketing should not cost the city more than $3,000 per market. Assuming a maximum of four markets (discussed in the following section) this would cost the city approximately $12,300 annually.

While the municipal costs are low compared to the first two policies, the benefits are much higher based on reductions to the excess mortalities and disease rates in Durham. In order to quantify this impact, the following process was used. First, a study of a farmers' stand at a health center found that its presence led to an increase of 0.5 daily vegetable servings consumed (Freedman et al., 2013). Next, several studies have address the effect of the number of daily vegetable servings on rates of preventable, weight-related diseases (Bazzano, 2005; Cene and Pignone, 2011). Taking seven studies reviewed from these two papers, and scaling their results to 0.5 servings, it was determined to lower disease rates by 5.4%. Applying a 5.4% reduction to the excess

mortalities and excess diabetes cases within a mile of the four market sites, this policy would reduce statistical deaths by 0.8 annually, and reduce diabetes cases by 21.5 cases annually. This leads to an annual health benefit of $6,491,000. Finally, the economic multiplies of local sales will also create benefit. According to a USDA survey of farmers' markets, the average vendor at small markets (2-9 vendors) had monthly sales of $1,705 (Ragland and Tropp, 2009). Assuming a minimum of two vendors per market, this would be $163,700 in annual sales. Applying the economic benefit of $0.60 in local spending for every dollar spent, this is another $98,200 spent locally. This brings the annual benefit to $6,589,200. Over the five years of implementation, the net present value is $28,471,900 in 2014 dollars.

Implementation and Feasibility

Of the eight proposed market sites, it is unlikely that a full-scale market could be supported at each location. Durham currently supports two farmers' markets, but both are in high-income areas. Furthermore, as the only markets, they draw a wide range of people willing to travel long distances for locally sourced food. The prospect of adding multiple markets in low-income areas is not nearly as profitable. They would likely need to be supported more directly by the local population, who are not as prepared to spend at high quantities. Furthermore, the fact that six of the proposed sites are at churches, means that Sunday would be the best day of the week, and six Sunday markets is not realistic. Therefore, it would be more reasonable to establish four full-scale markets: two at health centers during the week, and two at churches on Sunday. Full-scale markets are also a risky option. Due to the high cost of establishing and organizing a market, if it does not

fare well financially, it can set progress back. If vendors are not making enough sales, they will be wary of participating in markets in these low-income neighborhoods.

Affected Populations and Equity Concerns

This policy would provide direct and consistent access to fresh produce in food deserts. Depending on which food deserts are targeted, the equity concerns will differ. Targeting the two food deserts in the southeast of the city (deserts #1 and #2) would have superior effects on equity than the other two deserts, as they have higher child and minority populations, as well as lower incomes. However, this makes them less appealing to businesses than deserts #3 and #4. Therefore, more institutional support may be necessary to maximize equity benefits by encouraging locations in deserts #1 and #2. Finally, all sales from these markets would go to local businesses, helping the economy and providing additional benefits.

Improvability and Adaptability

This policy can be improved primarily through marketing to bring in customers and location selection. However, because the necessary permit lasts one year, locations cannot be adapted within a growing season. An unsuccessful year could mean the failure of a market and not give it time to test a new location. Therefore, while somewhat adaptable, this policy's adaptability is not ideal.

Policy 4: Mobile Markets

Costs and Benefits

The public costs of this policy would be similar to the full-scale markets, including marketing support and waived fees. However, the fee is only $10, so the cost

would be $65 less per market. Assuming that mobile markets can service each recommended location weekly, and each site receives marketing assistance, the cost would be $24,100 annually. The benefits calculation is performed in the same way for this policy; however, it larger in scale, as mobile markets can service more locations. Using the same baseline process as the previous section, statistical mortalities would be reduced by 1.5 annually, and diabetes cases reduced by 40.9 annually. This leads to health-based benefits of $12,327,900 annually. Finally we must apply the economic multiplier benefit. The USDA found that single vendors had average monthly sales of $1,202 (Ragland and Tropp, 2009). With eight vendor locations, this leads to annual sales of $115,400, and a benefit of $69,200 in additional local spending. Thus, the annual benefit is 12,397,200. Over five years, the net present value is $53,563,900 in 2014 dollars.

Implementation and Feasibility

Given the low public costs and high benefits, it should be very feasible politically. However, almost all the implementation would take place on the private side. With only one or two venders needed per market, it will be possible to service all the places of worship on the preferable weekend, and service health centers during weekdays. A business model similar to the Lo-Mo market would be preferable in order to provide consistent service.

Affected Populations and Equity Concerns

With the ability to service all of Durham's food deserts, mobile markets can target locations in deserts #1 and #2, which would have better equity effects, as well as the

likely more profitable locations in deserts #3 and #4. Also all the revenue would go to local businesses, so overall it would go a long way to address in equity concerns.

Improvability and Adaptability

Due to the less rigid location requirements and time commitments, mobile markets are highly flexible. They can test locations for only a week in order to determine the areas with the most customers. This gives this policy a high degree of improvability and adaptability.

VI. Recommendations

With clear public health concerns and a growing agricultural sector within Durham, actions to help improve access to fresh produce in food deserts should be strongly considered by the City Council, small businesses, and local community groups. Policy 1, no action, would do nothing to alleviate these problems, so that is not recommended. Policy 3, new farmers' markets, would help improve public health and support local businesses. However, it is a risky policy. It takes months, if not years of work to set up new markets. If these do not fare well financially, then it could set back the movement to introduce healthy food access in food deserts. Therefore, a combination of policies 2 and 4 is recommended. Small-scale mobile markets, with a clear schedule and weekly locations can provide access to fresh food in multiple food deserts throughout the each week. The Durham City Council can help support this initiative by fast-tracking the approval process, and providing EBT incentives to encourage new shoppers to attend these markets, and repeat shoppers to spend more. All of the money invested into these policies would be filtered back into the community.

Table 3: Policy comparison matrix for analysis criteria over five-year implementation period.

Policy Criteria	Status Quo	EBT/WIC Benefits	New Market Support	Mobile Market Support
Feasibility	Very High	Low	Low	Medium
Actors Required	None	City Council	Business, helped by City Council	Business, helped by City Council
Present Value of Public Costs	$764,886,000	$916,000	$56,000	$109,500
Present Value of Public Benefits	$0	$367,600	$28,527,800	$53,673,400
Present Value Net Benefit Change to Status Quo	$0	-$548,400	$28,471,900	$53,563,900
Equity Improvements	Low	Very High	Medium	High
Improvability	Low	High	Medium	Very High

The cost and benefit figures calculated in this report rely heavily on anticipated health benefits from improved food access. The high value of statistical life is responsible for the vast majority of the benefits from in policies 3 and 4. Thus, if the effects on mortality rates from weight-related diseases do not materialize, the benefits from these policies will be reduced drastically. While numerous studies and sources were referenced in order to calculate the expected changes in disease and mortality rates, small changes to those outcomes would greatly alter the results of these programs. Some of this uncertainty stems from the lack of studies demonstrating the long-term effects of farmers' market access to vegetable consumption. While many studies detailed the change in produce consumption during policy interventions, such as distributing coupons to be used at markets, only Freedman et al. (2013) examined long term changes in diets. Thus, this

analysis relies heavily on their conclusions that produce servings increased by 0.5 daily servings. If that trend did not translate directly to Durham, the cost benefit results would change.

Another complication with the results is that the cost benefit projections rely on good market attendance by food desert residents. Thus, while policy 2 (EBT and WIC benefits) has a negative net present value, it is vital that it be adopted along with new market creation in order to incentivize attendance as much as possible. Its negative NPV also does not account for the fact that many health benefits will be generated due to the increase in market attendance and produce consumption derived from these coupons. These health benefits are accounted for in policies 3 and 4. Therefore, EBT and WIC benefits should be seen as a strong complement to market creation that enables such high NPVs for those policies.

Adopting policies 2 and 4 would immediately and effectively improve access to fresh, locally produced food in Durham's food deserts. However, other options should be considered as well. Long-term policies, like increased nutrition education, health awareness, or community gardens should be a priority in low-income, and minority neighborhoods in Durham. Encouraging supermarkets to take advantage of federal policies to support supermarket infrastructure would help bring healthy food, jobs, and commerce to some of Durham's least privileged neighborhoods. The city could do this though information campaigns, partnerships with businesses, or creating their own incentives for supermarket to go along with federal ones. Food deserts cost Durham hundreds of millions of dollars annually. The city needs to work proactively to eliminate them in order to improve public health and the local economy. The policies

recommended here would be a starting point to immediately address the problem, however in the long-term, the city should use all the tools at its disposal to ensure food access for its citizens.

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